FORM PTO-1390 (REV 12-29-99)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 87805-9010

U.S. APPLICATION NO. (If known, see 37 CFR 1.5): 09/600654

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/GB99/00228	22 January 1999 (22.01.99)	22 January 1998 (22.01.98)

TITLE OF INVENTION: VIDEO SIGNAL COMPRESSION

APPLICANT(S) FOR DO/EO/US: Michael James Knee

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. [X] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [X] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [X] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [ ] have not been made and will not be made.
8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.
14. [ ] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [ ] Other items or information:

"Express Mail" mailing label number EL417145861US

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date of my signature and is addressed to Box PCT, Assistant Commissioner for Patents, Washington, D.C. 20231.

Nancy Dragolovich
(Typed or printed name of person mailing paper or fee)

Nancy Dragolovich
(Signature of person mailing paper or fee)

Date of Deposit 20 July 2000

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
09/600654	PCT/GB99/00228	87805-9010

17. ☒ The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

	CALCULATIONS PTO USE ONLY
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$970.00**	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$840.00**	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$690.00**	
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$670.00**	
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) **$96.00**	

ENTER APPROPRIATE BASIC FEE AMOUNT =				$ 840.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				$	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	11 - 20 =	0	X **$18.00**	$ 0	
Independent claims	2 - 3 =	0	X **$78.00**	$ 0	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$260.00**	$	
TOTAL OF ABOVE CALCULATIONS =				$ 840.00	
Reduction of 1/2 for filing by small entity, if applicable. A Small Entity Statement must also by filed (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$ 840.00	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$ 840.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	
TOTAL FEES ENCLOSED =				$ 840.00	
				Amount to be refunded:	$
				charged:	$

a. ☒ A check in the amount of $ 840.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 13-3080. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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Milwaukee, WI 53202

SIGNATURE:

Derek C. Stettner

NAME

37,945

REGISTRATION NUMBER

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re

International Application of

Knee

International Application No.
PCT/GB99/00228

International Filing Date:
22 January 1999

VIDEO SIGNAL COMPRESSION

PRELIMINARY AMENDMENT

BOX PCT
Assistant Commissioner for Patents
Washington, DC 20231

Sir:

Please amend the application as follows prior to calculation of the filing fees.

IN THE CLAIMS

In Claim 3, line 1, delete "or Claim 2".

In Claim 4, line 1, delete "any one of the preceding claims" and insert --Claim 1--.

In Claim 7, line 1, delete "any one of the preceding claims", and insert --Claim 1--.

REMARKS

The claims have been amended to remove multiple dependent claims and to conform to U.S. Patent Office practice. Please enter this amendment before calculating the filing fees.

Respectfully submitted,

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VIDEO SIGNAL COMPRESSION

The invention relates to video signal compression.

In an important example, the invention concerns the MPEG-2 video signal compression standard, ISO/IEC 13818-2, though it can be applied to any video compression system that is liable to degradation when coding and decoding are cascaded.

There has already been disclosed (WO-A-9535628) the use of a signal which accompanies an MPEG bitstream and which carries information about the bitstream for use in a downstream process, for example, the re-encoding of a decoded MPEG picture. This signal is provided in parallel and is sent along an appropriate side channel to accompany a decompressed signal from a compression decoder to a subsequent encoder.

Where equipment has been specifically designed for use with such a signal, considerable advantage can be gained and many of the problems previously associated with cascaded coding and decoding processes are removed or ameliorated by using in a downstream coding process, key information concerning upstream coding and decoding.

In WO-A-9803017, there are disclosed techniques which extend these advantages, in part or in whole, to arrangements which include equipment not specifically designed for use with such a signal. Specifically, these techniques include embedding the information signal in the video signal so that it can pass transparently through a video pathway.

It is an object of this invention to provide improved apparatus and processes which offer benefits not just in a cascaded recoding operation but in a primary coding operation.

Such a primary coding operation will usually be applied to a video signal which has not previously been compressed. The possibility is included, however, of a "primary" coding operation on a video signal which has been compressed but without advantage having been taken of any of the techniques disclosed in either of the above referenced documents.

Accordingly, the present invention consists, in one aspect, in a video signal process comprising the steps of analysing a video signal and taking compression coding decisions; forming a representation of the coding decisions for passage with the video signal along a video pathway and, downstream of the video pathway, compression encoding the video signal in accordance with said coding decisions.

In another aspect, the present invention consists in compression pre-processing apparatus, comprising means for analysing a video signal and taking compression coding decisions; means for processing the coding decisions and means for outputting the processed coding decisions for passage with the video signal along a video pathway.

The coding decisions may include the following information: picture dimensions; frame rate; picture structure (frame-coded or field-coded); picture type (I, P or B): whether macroblocks are intra-coded or use prediction; whether forward, backward or bi-directional prediction is used; motion vectors; transform type; quantizer visibility weighting matrices; quantizer step; bit rate and buffer state of a downstream decoder.

In this description, the term information bus is used to represent information relating to a coding operation, which information accompanies a decoded signal, a partially decoded signal or a yet-to-be-coded signal. More detail can be found with reference to WO-A-9535628. The information bus is preferably embedded within a video signal for example as disclosed in W0-A-9803017. The content of both WO-A-9535628 and W0-A-9803017 is herein incorporated by reference.

The invention will now be described by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a block diagram of a compression pre-processor according to one embodiment of this invention;

Figure 2 is a block diagram of a compression pre-processor according to a second embodiment of this invention; and

Figure 3 is a block diagram illustrating three alternative server-based processes according to this invention making use of the information provided by the pre-processor of Figure 1 or Figure 2.

Turning to Figure 1, an input video signal which has not previously been encoded is presented at input terminal 100 and passes to an MPEG2 encoder 102. This encoder takes one of the forms disclosed in WO-A-9535628 and has in addition to the MPEG output, an information bus output on which appear a representation of the coding decisions taken in the encoder. These coding decisions may include the following information: picture dimensions; frame rate; picture structure (frame-coded or field-coded); picture type (I, P or B): whether macroblocks are intra-coded or use prediction; whether forward, backward or bi-directional prediction is used; motion vectors; transform type; quantizer visibility weighting matrices; quantizer step; bit rate and buffer state of a downstream decoder.

The information bus then joins the input video signal for passage in tandem along a video pathway. It should be noted that the video signal at the output has undergone no processing, beyond delay in an appropriate compensating delay 104.

There are a variety of preferred ways in which the information bus can accompany the video signal. For example, the information bus can be carried in the least significant bit of the colour-difference part of a 10-bit ITU-R Rec. 656 signal, within the active video region only. This provides a raw bit-rate of 10.368 Mbit's for the information bus. Care will be taken to ensure that the presence of this additional information does not cause visible impairments to the video signal and that studio equipment quoted as '10 bits' is indeed transparent to all ten bits of the signal when no mixing or other processing is being performed. In other implementations, the information bus might be transported in the 9th or 8th colour-difference bit, in the 10th, 9th or 8th luminance bit or in any combination of the above. Use of the 8th bit would also be appropriate for systems using earlier versions of the Rec. 656 standard where only 8-bit representation is available.

Another example is an extension of the above approach, in which any part of the digital video signal (not just the least significant bit) is modified by adding the information bus data to the video in such a way that a downstream MPEG coder would be unaffected.

It is also possible to carry the information bus in an ancillary data channel carried in the blanking periods of the Rec. 656 signal. It would be necessary to ensure that studio equipment passed this information unchanged when no mixing or other processing was being performed.

A still further example is to send the information bus as an AES/EBU digital audio channel. This would be passed through a spare channel in the audio path of the studio equipment. It would be necessary to ensure that switching of that particular audio channel would be performed along with the video switching, even though the main audio channel(s) might be switched independently of the video.

Figure 2 shows a more detailed configuration of a compression pre-processor according to the present invention. An information bus generator 202 receives the input video signal and generates a 'skeleton' information bus containing picture, GOP and sequence rate information relating to the input video signal, for example, picture size, aspect ratio, field/frame coding type and picture type. The video signal and the skeleton information bus are passed to a motion estimator 204. This generates candidate motion vectors which are placed on the Information Bus. A prediction selector 206 receives both the video signal and the information bus and selects between the different candidate motion vectors. It also selects which prediction mode (field, frame, forward, backward, bi-directional etc.) is to be used for each macroblock. The prediction selector 206 further performs inter/intra selection and DCT type selection.

The information bus at the output of the prediction selector 206 contains all the decisions necessary for the creation of an MPEG bitstream apart from those relating to quantization. These are provided as follows.

A "dumb" coder 208 operates on the video signal, guided by the coding decisions represented in the information bus. A bit rate controller 210 receives the coded bitstream and controls the quantization in the dumb coder to bring the output bit rate to a notional bit rate representing the probable output rate of a downstream encoder. The dumb coder then places on the information bus the quantizer information employed to generate a bitstream at the desired notional bit rate

So far, what has been described in Figure 2 is identical to an MPEG coder, based on the information bus as shown in the referenced prior publications. In this application, however, the bitstream is not used and only the final information bus appears at the output of the coder 208.

This information bus is then processed using techniques described in WO-A-9803017. Briefly, the information bus passes to an information bus coder 212 which performs variable length coding, packetisation and allocation of time stamps. This represents a convenient form of compression using, essentially, the MPEG2 syntax. Indeed, the information bus in one form can be viewed as the MPEG2 bitstream minus the DCT coefficients.

There are various possibilities for the format of an information bus signal, according to its timing relationship with the video signal it accompanies. Formatting is carried out by the information bus formatter 214. Examples of possible formats for the information bus signal are as follows:

(i) A fixed-bit-rate signal but containing a variable number of bits per picture and transmitted with no regard for synchronisation to the video signal. In practice, the signal could have a variable bit-rate but could be made to occupy a fixed-bit-rate channel by the use of stuffing bits.

ii) A fixed or variable-bit-rate signal which is re-ordered (from bitstream order to display order within the GOP structure) and time-shifted so that the information bus for each picture is co-timed with the video signal for that picture.

iii) A mixture of the two, in that the information bus itself is asynchronous but a small slot is reserved for some picture-locked data; this would carry, for example, duplicates of **time_code** and **picture_type.**

iv) A fixed-bit-rate signal which is re-ordered and time-shifted as described in the second option above, but additionally arranged so that the macro-rate information for each macroblock is co-timed with the video signal corresponding to the macroblock.

The formatted information bus then passes to a channel adapter 216, which adapts the information bus to accompany the video signal (which has been delayed in compensating delay 218) in any of the ways described by way of example with reference to Figure 1. Thus, in a preferred example, the

channel adapter 216 embeds the formatted information bus in the least significant bit of the colour-difference part of a 10-bit ITU-R Rec. 656 signal, within the active video region only.

In a modification to the arrangement illustrated in Figure 2, two or more dumb coders 208 and associated bit rate controllers 210 could work in parallel, each at a different bit rate covering the range of likely future requirements. The quantizer information generated at each bit rate could be recorded in the information bus.

In a further alternative, the bit rate controller 210 could be removed and the dumb coder or coders 208 could work with a fixed quantizer or quantizers. The resulting numbers of bits generated for each macroblock could then be recorded in the output information bus.

Figure 3 shows how a pre-processor according to this invention might be used in conjunction with a server designed for uncompressed video signals. The pre-processor works as described above to add an information bus to a digital video signal. The resulting video + information bus signal is written onto a server. There are then shown three examples of how the signal might be used downstream to produce bitstreams.

In each example, the signal is read from the server and sent to an Information Stream decoder which passes the resulting video and Information Bus signals to a dumb coder.

In the first example, dumb coder 1 simply slaves to the incoming video and information bus signals and produces a bitstream at the bit rate (or a chosen one of the bit rates) generated by the pre-processor.

In the second example, dumb coder 2 works at a new bit rate. The quantizer information in the information bus is ignored and is replaced by quantizer information calculated by the local bit rate controller.

In the third example, (enhanced) dumb coder 3 makes use of both the local bit-rate controller and the quantizer or bit-count information decoded from the information bus to improve the performance of the encoder. Effectively, the known benefit of two-pass encoding is obtained, that is to say pre-analysis and a second pass through the bit rate control process.

Either of the second two configurations could be used as part of a bitstream switch or other bitstream processor in which it is necessary to control the bit rate and the occupancy of the coder buffer.

Whilst the use of an information bus which is effectively the MPEG stream minus the DCT coefficients, is extremely convenient, other options exist for representing the coding decisions. A range of formats could be employed and various compression techniques employed. In addition to the coding decisions, useful statistical information from the coding process can also be carried.

Note that the present invention is not confined to MPEG2 compression. It could be used with a wide variety of compression technique, or even with mixtures of techniques, although in this case the processing of the decoded information bus would be significantly more complicated, as it would involve the re-interpretation of coding mode information for a different compression scheme.

It should be understood that this invention has been described by way of examples only and a variety of further modifications are possible without departing from the scope of the invention.

CLAIMS

1. A video signal process comprising the steps of analysing a video signal and taking compression coding decisions; forming a representation of the coding decisions for passage with the video signal along a video pathway and downstream of the video pathway compression encoding the video signal in accordance with said coding decisions.

2. A process according to Claim 1 wherein said representation of the coding decision comprises an information bus in which the coding decisions are represented in the same format as they are represented in the compressed bitstream which is the output of said downstream compression coding operation.

3. A process according to Claim 1 or Claim 2, wherein said analysis generates information relating to picture size and type.

4. A process according to any one of the preceding claims, wherein said analysis comprises the generation of candidate motion vectors.

5. A process according to Claim 4, wherein said analysis comprises the selection for each macroblock of the picture of a motion vector from said candidate motion vectors.

6. A process according to Claim 5, in which said analysis comprises the selection of a macroblock prediction mode.

7. A process according to any one of the preceding claims wherein said analysis includes a bit rate control and the taking of quantizer decisions appropriate to the maintenance of the selected bit rate.

8. A process according to Claim 5 wherein plural bit rates are selected and plural quantizer decisions taken.

9. Compression pre-processing apparatus, comprising means for analysing a video signal and taking compression coding decisions; means for processing the coding decisions and means for outputting the processed coding decisions for passage with the video signal along a video pathway.

10. Apparatus according to Claim 9, wherein said means for processing the coding decisions provides a representation of the coding decisions in the form of an compressed video bit stream lacking transform coefficients.

11. Apparatus according to Claim 9, wherein said means for outputting the processed coding decisions serves to modulate one or more least significant bits of the video signal.

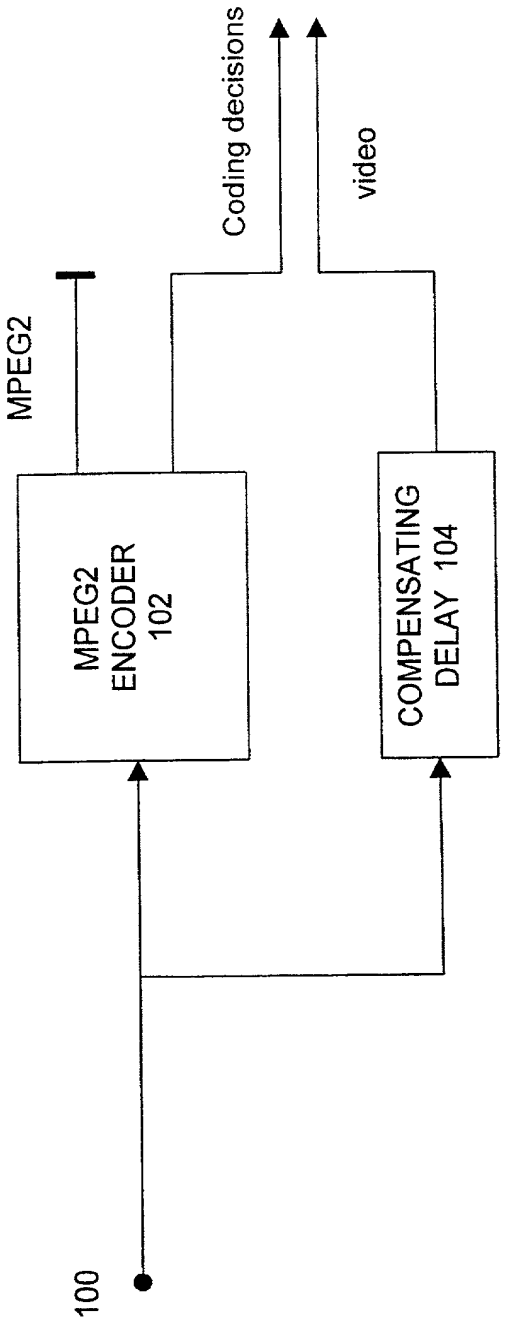
Coding decisions
video
MPEG2
MPEG2 ENCODER 102
COMPENSATING DELAY 104
100

FIGURE 1

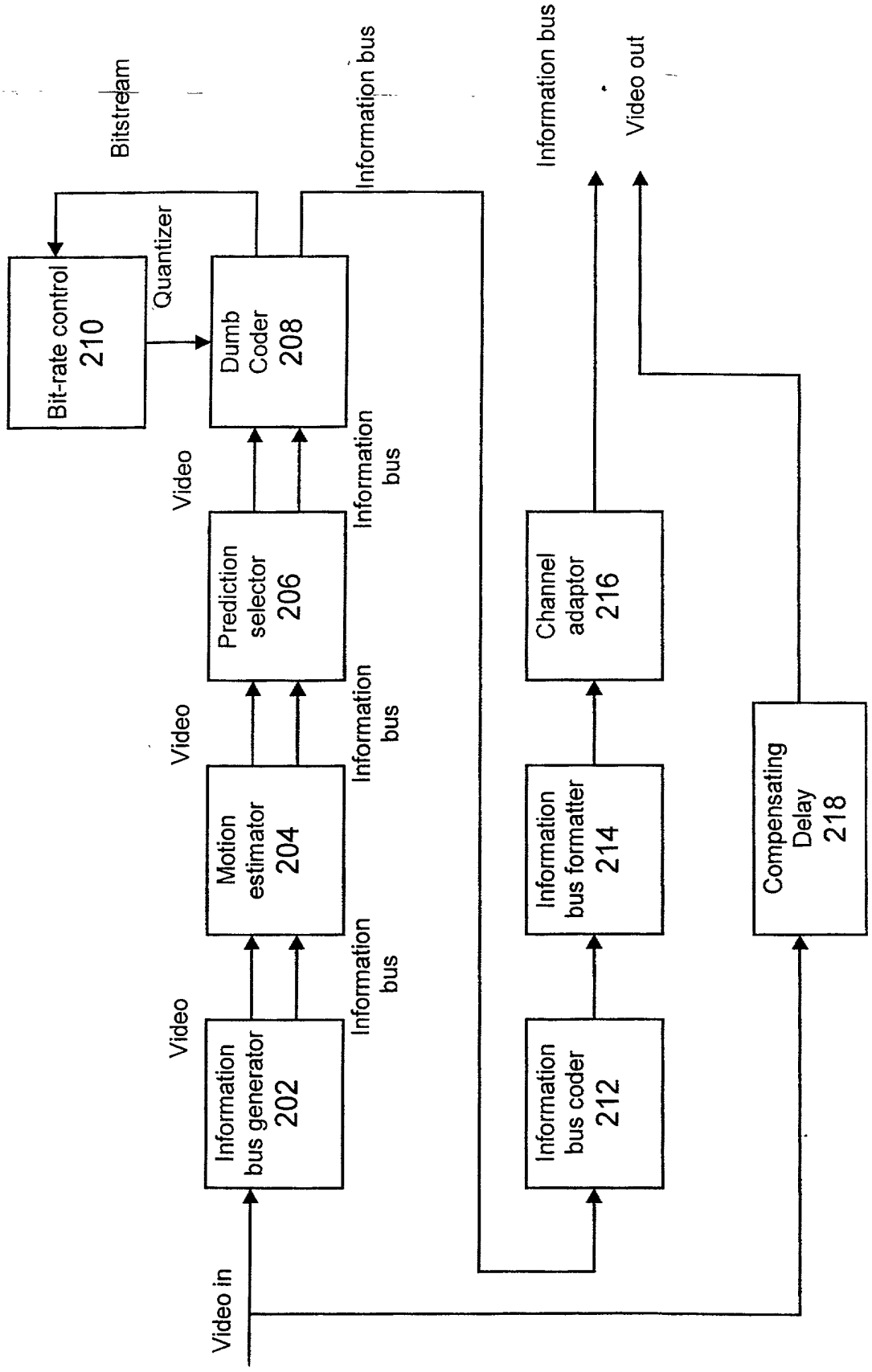
Video in
Information bus generator 202
Motion estimator 204
Prediction selector 206
Dumb Coder 208
Bit-rate control 210
Information bus coder 212
Information bus formatter 214
Channel adaptor 216
Compensating Delay 218
Video
Information bus
Quantizer
Bitstream
Video out

FIGURE 2

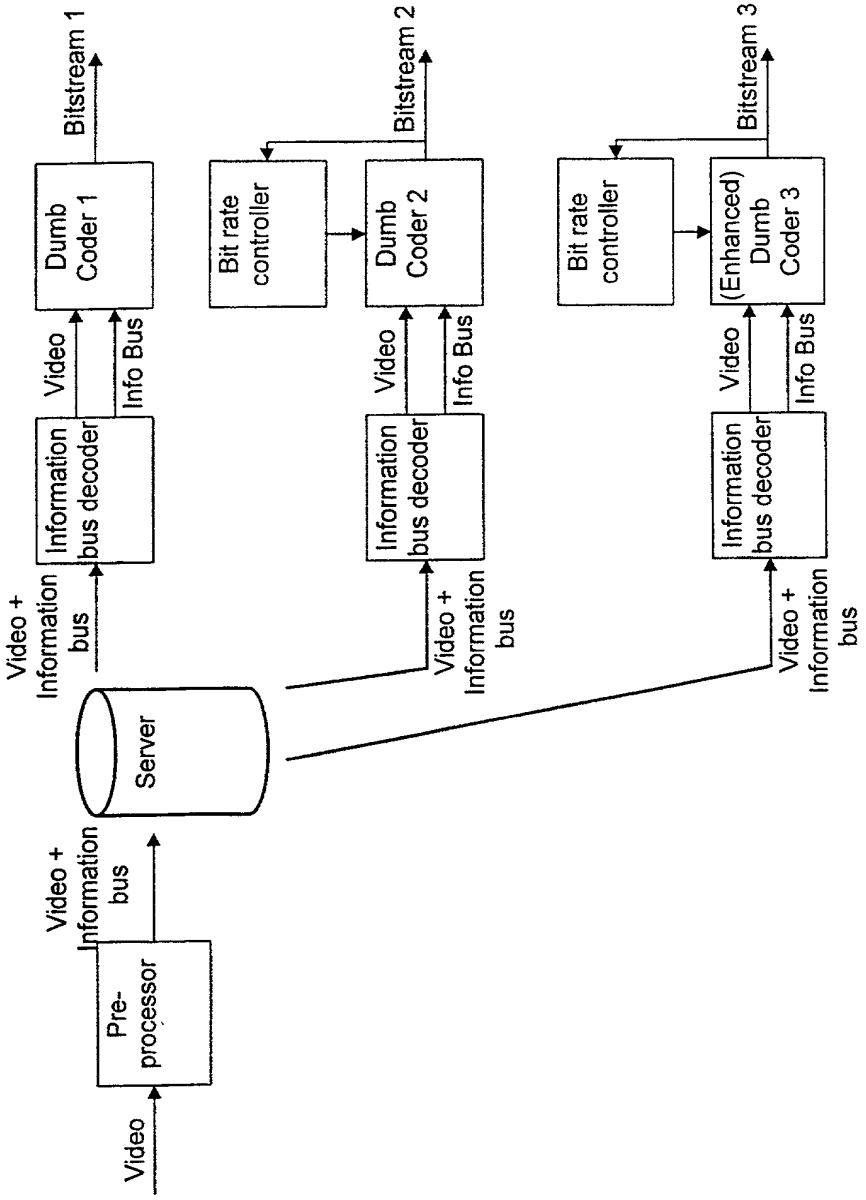
Video
Pre-processor
Video + Information bus
Server
Video + Information bus
Information bus decoder
Video
Info Bus
Dumb Coder 1
Bitstream 1
Video + Information bus
Bit rate controller
Dumb Coder 2
Bitstream 2
Video + Information bus
Information bus decoder
Video
Info Bus
Video + Information bus
Bit rate controller
(Enhanced) Dumb Coder 3
Bitstream 3
Information bus decoder
Video
Info Bus

FIGURE 3

Declaration and Power of Attorney For Patent Application

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original, first inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled "VIDEO SIGNAL COMPRESSION" (Attorney Docket No. 87805-9010-00), the specification of which was filed with my authority, on July 20, 2000 as Application Serial No. 09/600,654.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims referred to above.

I acknowledge the duty to disclose to the Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

And I hereby appoint Derek C. Stettner (Reg. No. ~~37,945~~), Christopher B. Austin (Reg. No. 41,592), David L. De Bruin (Reg. No. 35,489), Gerald L. Fellows (Reg. No. 36,133), Randall W. Fieldhack (Reg. No. 43,611), Joseph A. Gemignani (Reg. No. 19,482), Gregory J. Hartwig (Reg. No. P-46,761), Daniel S. Jones (Reg. No. ~~42,697~~), Richard L. Kaiser (Reg. No. 46,158), Timothy M. Kelley (Reg. No. ~~34,201~~), Casimir F. Laska (Reg. No. 30,862), Edward R. Lawson, Jr. (Reg. No. 41,931), Richard H. Marschall (Reg. No. 39,290), Thomas A. Miller (Reg. No. ~~36,871~~), Kevin P. Moran (Reg. No. 37,193), Andrew R. Peret (Reg. No. 41,246), David R. Price (Reg. No. 31,557), Thomas S. Reynolds II (Reg. No. 45,262), David B. Smith (Reg. No. 27,595), Billie Jean Strandt (Reg. No. 36,940), Sheldon L. Wolfe (Reg. No. 43,996), Paul F. Donovan (Reg. No. 39,962), Grady J. Frenchick (Reg. No. ~~29,018~~), Karen B. King (Reg. No. 41,898), Linda Blair Meier (Reg. No. 39,769), Teresa J. Welch (Reg. No. 33,049), Robert S. Beiser (Reg. No. 28,687), Witold A. Ziarno (Reg. No. ~~39,888~~), and each or any of them, my attorneys or agents, with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

ADDRESS ALL COMMUNICATIONS IN OR PERTAINING TO THIS APPLICATION TO:

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Michael Best & Friedrich LLP
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I hereby claim foreign priority benefits under Title 35, United States Code, §119 of the foreign application for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application

(Number)	(Country)	(Day/Month/Year Filed)
PCT/GB99/00228	PCT	22 January 1999
9801382.4	UK	22 January 1998

The undersigned to this Declaration and Power of Attorney hereby authorize the U.S. attorneys named herein to accept and follow instructions from

Snell & Wilcox Limited
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United Kingdom

and/or its agent Peter Douglas Garratt
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London WC1X 8AL United Kingdom

as to any actions to be taken in the U.S. Patent and Trademark Office regarding this application without direct communication between the U.S. attorneys and the undersigned. In the event of a change in the person(s) from whom instructions may be taken, the undersigned will so notify the U.S. attorneys.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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